



Baden-Württemberg

LANDESGESUNDHEITSAMT BADEN-WÜRTTEMBERG
IM REGIERUNGSPRÄSIDIUM STUTT GART

Interventions and Actions against Damp and Mould in Warm Climate Countries

Interventions and Actions against Damp and Mould in Public or Institutional Settings

**Addendum to the WHO expert meeting report on
interventions against damp and mould
(February 2008)**



WHO Collaborating Centre
for Housing and Health



Landes Gesundheits Amt
Baden-Württemberg

This report was prepared by the WHO Collaborating Centre for Housing and Health in the context of a WHO project on the policy implications of actions against damp and mould.

At a first meeting in February 2008, a selected list of case studies was discussed and reviewed by international experts in order to identify potential elements of good practice and assess effective technical solutions and approaches. However, most of the case studies contributed by the research community and/or member states focused on damp and mould interventions in the home and private setting, while public institutions (schools, day care centres etc.) were only marginally covered. Similarly, case studies tended to come from the Northwestern part of the EU, with a significant underrepresentation of actions and interventions undertaken in southern countries and warmer climates.

This report was developed by the WHO Collaborating Centre for Housing and Health to compile current knowledge on activities and interventions undertaken in institutional settings and in warm-climate countries to add to the 2008 meeting report and case studies compiled for this meeting.

The report of the expert meeting on damp and mould interventions – and the list of case studies – can be obtained via the WHO Housing and health website
http://www.euro.who.int/Housing/support/20080403_3

Impressum

Baden-Württemberg State Health Office
(Landesgesundheitsamt Baden-Württemberg)
im Regierungspräsidium Stuttgart
WHO Collaborating Centre for Housing and Health
Nordbahnhofstr. 135 · 70191 Stuttgart
Tel. +49 (0)711 904-35000 · Fax +49 (0)711 904-35010 · abteilung9@rps.bwl.de
www.rp-stuttgart.de · www.gesundheitsamt-bw.de

Contact
Dr. Bernhard Link
bernhard.link@rps.bwl.de

November 2009

Table of content

Interventions and Actions against Damp and Mould in

1) Warm Climate Countries 4

2) Public or Institutional Settings 9

1) Warm Climate Countries

According to EUROSTAT data from 2006, the proportion of the total population living in homes with self-reported problems of dampness in countries of Southern Europe varied widely between 8.1% in Malta and 33.8% in Cyprus. Self-reported problems of dampness in the home in the Southern Countries Italy (21.9%), Greece (20.8%), Portugal (20.0%) and Spain (17.3%) were lower than in the East-Central European countries Poland (40.0%), Latvia (31.3%), Lithuania (28.0%), Hungary (27.8%), Estonia (24.6%) and Slovenia (22.3%). On the other side, they were higher than in the Northern European countries Denmark (8.5%), Norway (8.1%), Sweden (6.6%) and Finland (4.6%). However, [Haverinen-Shaughnessy \(2007\)](#) points out that “Eurostat defines damp as ‘rot in the house or damp or leaky roof’” ([EU-SILC USER DATABASE DESCRIPTION \(draft\)](#), variable X-L HH040: LEAKING ROOF, DAMP WALLS/FLOORS/FOUNDATION, OR ROT IN WINDOW FRAMES OR FLOOR) and that “the definition as such seems to exclude many types of dampness and moisture problems, which may be a reason why, for example, several cross-sectional studies conducted in Finland have reported much higher prevalence values”.

In Italy, Greece, Portugal and Spain, where data on self-reported problems with damp have already been collected in the years 1995 and 2001, a decreasing trend can be observed.

A study conducted by [Li and Hsu \(1996\)](#) in Taipei, Taiwan, which has a subtropical climate, found a prevalence of self-reported dampness in the home of 36.8%, whereas “classified” dampness (presence of mould, water damage or flooding) was found in 72.3% and presence of mould was found in 38.3% of the homes. In day care centres, in the same area, dampness was found in 75.3% of the centres, visible mould in 25.8% ([Li et al. 1997](#)).

In the European Community Respiratory Health Survey, geographical variation in the prevalence of sensitisation to nine common aeroallergens in adults aged 20-44 years in 15 developed countries was assessed by skin prick tests ([Bousquet et al. 2007](#)). Included were the two mould species *Cladosporium herbarium* and *Alternaria alternata*, which are primarily outdoor species. Mean (min-max) prevalence of sensitisation in the 15 countries was 1.7 % (0-11.9%) against *Cladosporium* and 3.3 % (0.2-14.4%) against *Alternaria*. In the Southern European countries Italy and Spain, sensitisation against mould was lower or equal to 0.9 % (0.3-1.5 %) for *Cladosporium* and 3.6 % (2.2-5.0 %) for *Alternaria* in Italy and 0.5 % (0.1-0.8 %) for *Cladosporium* and 1 % (0.5-1.5 %) for *Alternaria* in Spain.

[Aira MJ et al. \(2008\)](#) conducted an analysis of the frequency distribution of *Cladosporium* and *Alternaria* spores in the atmosphere in the north-western Iberian Peninsula. They found the highest concentrations for *Cladosporium* and *Alternaria* in most continental centres, reaching a yearly total average of approximately 300 000 spores per m³, and the lowest levels in coastal cities. Highest concentrations were observed in July, August and September, depending on mould type. The main sporulation period was between mid-April and mid-October and the duration was between 135 and 258 days, depending on mould type and location. The highest spore levels were found during afternoon with smaller variations in coastal centres. The authors observed a high correlation between mean temperature and spore levels of *C. cladosporioides* and maximum temperature and spores of *C. herbarum* and *Alternaria*, respectively. [Gómez de Ana S et al. \(2006\)](#) analysed the seasonal distribution of four mould genera (*Alternaria*, *Aspergillus*, *Cladosporium* and *Penicillium*) in 22 homes of patients with allergy to fungi in Spain, which is part of the Iberian Peninsula. The authors found a considerable seasonal variability in the four fungal genera. In indoor environments, the highest concentration of *Aspergillus*, *Cladosporium* and *Penicillium* was found in autumn, whereas concentration of *Alternaria* was higher in summer. Statistical significant differences between indoor and outdoor concentrations of the species was only found for *Alternaria*. The highest numbers of colony-forming units per cubic meter (cfu/m³) were found for *Cladosporium* and *Penicillium*. However, mean concentrations were 33.05 and 16.5 cfu/m³, respec-

tively, which is low according to the Commission of the European Community. Fungal concentrations below 500 cfu/m³ are considered low, between 500 and 999 cfu/m³ are considered intermediate and those above 1000 cfu/m³ are considered high by the commission.

[Aydogdu and Asan \(2008\)](#) determined concentration and sources of indoor and outdoor mould in sleeping room, eating room and classroom of four day care centres of Edirne, North west region of Turkey. Viable spore counts were highest in June and lowest in January/February. The authors found a strong negative correlation between monthly average wind speed and monthly outdoor CFU counts and a positive correlation between monthly average temperature and monthly outdoor CFU counts. Because outdoor air is the main source of airborne fungi in indoor air, the authors suppose that climatic variations might also have an influence on concentrations and types of fungi in indoor air. The highest fungal concentration was found in the eating room of the first day care centre. Unlike the eating rooms in the other three day care centres, this one was used to prepare, cook and serve food. The eating room of day care centre 2, which was only used short-time for meal consumption and had a rather good ventilation, had the lowest fungal concentration.

[Howden-Chapman et al. \(2005\)](#) assessed risk factors for mould in New Zealand housing in a national random telephone survey. In general, in New Zealand there is a high level of dampness in housing, a relatively poor housing stock and inadequate insulation and heating. Of the 613 respondents, 35.1% reported mould in one or more rooms. Poorer house condition, older house age (>22 years), relative lack of sun exposure and having no insulation were independently associated with reported mould. Additionally, an increased risk for mould in the home was found in case of high locality rainfall and living in the most northern part of the country, which has a subtropical climate. In the northern half of North Island, 40,5% of the respondents reported mould in any room of the house, whereas in the other parts of the country this proportion varied between 25.4% and 32.3%. Consequently, mould in the home was positively associated with annual average temperature and humidity.

Concerning policy implications, the authors wrote “Policy responses to prevent mold and dampness might include changes to regulations around housing design including house position, access to sunlight, level of insulation, and site drainage. Low-interest loans for insulation or subsidized installation may help to increase the level of insulation. Restrictions on the sales of unflued gas heaters” (which produce large amounts of water vapour during normal operation) “could also be considered. A mass media campaign could inform the public about how best to prevent and control mold growth and dampness. “ ... “Such interventions may also reduce energy costs for householders. Furthermore, they could also help the government meet such national goals as improving energy security and meeting Kyoto Protocol commitments for reducing greenhouse gas emissions associated with energy use. At a social policy level, improved access to social housing may reduce the risk of high numbers of residents per house - which in this study was significantly associated with reported mold.”

To investigate humidity in buildings in a hot and humid climate, [Lucas et al. \(2002\)](#) conducted a series of experiments in the frame of a curative and a preventive study on two different types of residences in Reunion Island, which has a very humid climate. According to German Wikipedia, the Eastern part of the island established the world record in rainfall in the space of 24 hours in 1952. The study was conducted in the highlands of Reunion Island in southern winter, which is characterized by a low dry-bulb temperature of the air, strong moisture and very low wall surface temperatures. The authors used numerical simulations to extrapolate the behaviour of the buildings on unusual climatic sequences. In a first step, the significant points of an existing building envelope regarding to condensation phenomena were defined and useful data for the building description were validated. The measurements showed that simulations should target more particularly the change of the roof surface temperatures and walls directed to the south. Because quantities of condensate were likely to stream under rigorous

climatic conditions, ventilation of the roof air layer must be taken carefully as it can generate an increase in condensation.

In the second step, the risk of condensation in a project building located in a very humid area was investigated. To consider the hygroscopic material of the structure, the authors used a simulation code integrating a buffer storage model. The simulations were focused on the influence ventilation or heating, the ground and the panes of glass. The authors conclude that if heating implies a substantial investment, ventilation remains the best solution against condensation. Condensation on the floor can be avoided by insulation.

[Lourenco et al. \(2006\)](#) investigated moisture problems in ancient buildings in the historical centre area of Braganca, a city located in the North-East of Portugal. There are two areas, which can be differentiated. The first, Citadel, is located inside the walls and is the oldest part of the city, which later grew outside the walls with more spacious and wealthier houses. The second area, which grew on the background of a wealthier population, is located outside the walls. The houses of the Citadel are predominantly detached or semi-detached with one or two floors, plane facades and double sloping roof and simple construction. Indoor conditions have been investigated in a subsample of 16 of these houses in more detail in this study, including an interview with the inhabitants. Because the buildings in the Citadel are older, of poorer construction and are more abandoned, the damage in these buildings was almost always larger than the damage in the buildings outside the walls.

The analysis of the data from the 16 houses showed the following results:

- Occupant density is rather low, on average three people live in a house in the Citadel. Therefore, overpopulation is not a cause for water condensation.
- There is an evident lack of ventilation with 87% of the houses having at least one internal compartment without any ventilation system. Often there is no mechanical exhaust system, and opening of windows is the only possibility for ventilation.
- Most houses have an East–West orientation, but narrow streets induce shading and prevent sun exposure. Therefore, solar gains are very low.
- Heating systems are low tech and not continuously working, which is common in Portugal. Exclusively the compartments under use are heated, and only when the occupants are there.
- Half of the occupants use gas heating systems, often combined with wood and electricity systems. This causes an increase of the water vapour in the air.
- In winter it is common to dry clothes inside the houses, which is a major source of moisture. Bathrooms are not present in 21% of the houses.
- Rooms are usually very small, e.g. the bedroom area is, on average, only 8m². Often the kitchen and the living room are parts of the same compartment.
- Roofs have broken tiles and severely damaged timber elements. Frequently, downpipes do not exist and, if present, they are normally obstructed, severely damaged or incomplete. In some cases, the windows and door frames are also very deteriorated.
- The attempts to obtain better housing conditions occur without appropriate technical support, using remedial measures such as aluminium window frames and placement of water-vapour-proof linings in the roof, which, in most of the cases, worsens the conditions of these residential units.

The three-day records of temperature and humidity showed very low temperatures in winter, particularly in rooms seldom used. As mentioned above, the heating system is localized and is only used in the room where the occupant is, and only during his presence. Indoor temperatures around 3^oC were observed in empty rooms, with an average of 6.7^oC. The temperature is higher in the rooms used during the day, namely kitchens and living rooms, although still very low (about 9–10^oC). The external temperatures in this period were between -5^oC and

+6°C. The relative humidity in the air was higher in colder spaces and reached, in general, values above 75%. In the houses where the fireplace is used as a heating system, the relative humidity values were lower. Due to the poor quality of the building envelope, the indoor temperatures are frequently very close to the exterior ones.

The authors mention that this situation is “typical of historical city centres in Northern Portugal, characterized by considerable rain and cold temperatures.”

[Basilico M et al. \(2007\)](#) investigated concentration and types of fungal spores in indoor air in 49 houses from urban and suburban areas of Santa Fe city, Argentina, during one year. Santa Fe city has a warm climate with an annual mean temperature of 18.6°C and a relative humidity of 74.6%. Mean (min-max) total indoor fungal concentrations were 977 (186-3090) cfu/m³. Fungal levels in external air were similar to those found indoors. In general, winters are not cold enough to keep the windows shut throughout the season in this area. Therefore, fungal concentrations indoors are greatly dependent on outdoor concentrations, especially in non-heated houses. Indoor fungal concentrations were not affected by wind direction, even if there was an outdoor source area. The orientation of the main doors and windows in relation to north-south winds, which are typical in the region, did not result in significant differences in indoor fungal concentrations. Concentrations of *Cladosporium*, the most frequently found species, were significantly influenced by the presence of a heating system, but not by the season. In *Alternaria*, the second most frequently found genus, it was the other way round.

The Manufactured Housing Research Alliance (MHRA) in cooperation with the U.S. Department of Housing and Urban Development (HUD) initiated a study to address the moisture problems observed in U.S. Gulf Coast (which has a hot and humid climate) manufactured homes ([Alternatives for Minimizing Moisture Problems in Homes Located in Hot, Humid Climates: Interim Report, 2003](#)).

MHRA visited a sample of manufactured homes with moisture problems in hot, humid climates and identified a set of key construction, installation, maintenance, and operational characteristics and moisture damage patterns. Analysis of this data was undertaken to identify which of these characteristics were more strongly associated with the moisture related damage and that, consequently, could be used to control such occurrences.

The following possible contributors to moisture problems were identified

1. Pressure imbalances

- **Imbalances in the distribution of conditioned air.** Imbalances in air pressures within the home and between the home and the outside were found to be significantly associated with moisture problems, particularly when they were amplified by closed interior doors.
- **Duct leakage to the outside.** Despite the fact that specific duct leakage test data did not correlate strongly with moisture problems, results did indicate that air distribution imbalances (to which duct leakage contributes), manifested as pressure imbalances, have a significant impact on moisture problems.
- **High rate of shell leakage.** Shell leakage alone did not correlate strongly with moisture problems; however theory states that it will contribute to humidification of the home if negative pressures with respect to the outside exist within the living area.

2. Non-continuous vapour retarder and air barrier

- **No ground vapour retarder under the home.** Findings indicate that ground vapour retarders are effective in protecting homes from moisture damage, but only where a sufficiently designed drainage system prevents the accumulation of water under the home.

- **Damage to the bottom board.** Data indicated that the bottom boards of many homes experiencing floor moisture problems were damaged, indicating a need to develop guidelines for manufacturers, installers and owners to prevent damage to bottom boards and to facilitate repairs of those already damaged.
- **Interior wall vapour retarder ineffectiveness.** The literature review indicated that there is merit to a waiver allowing vapour permeable interior wall surfaces that will allow wall cavities to dry toward the interior of the home, in conjunction with a vapour retarder on the exterior in hot, humid climates. Further testing should be conducted to verify this recommendation.
- **Lack of exterior air barrier.** Analysis of the data and review of the pertinent literature indicates that air barriers should be located on the exterior wall surface in hot, humid climates to prevent the introduction of hot, humid air into building cavities that can contribute to condensation. Measures to limit outside air movement into building cavities should be explored.
- **Ventilated attic space.** From the limited data collected in this study on the effects of attic ventilation on moisture problems, it does not appear that ventilating attics contributes to ceiling moisture problems in hot, humid climates.

3. Occupant Comfort

- **Low thermostat setting.** As hypothesized at the beginning of the data collection process, low interior temperatures contribute to moisture problems. Interim findings indicate that thermostat set points should be no lower than 71°F.
- **Local cold spots.** Local cold spots such as those created by cold air registers directed on floor surfaces, though not specifically studied in the field, are hypothesized to contribute to certain moisture problems.
- **Introduction of unconditioned outside air.** Introduction of unconditioned outside air into the home through the whole house ventilation system was not specifically part of the data collection effort in the initial phase of the study.
- **Oversized air conditioning equipment.** The results indicated that proper sizing air conditioning equipment would be effective in addressing moisture problems only when combined with good air distribution design practices, i.e. a balanced system.

2) Public or Institutional Settings

The main purpose of this report is to assess whether there are any specific interventions taking place in public institutions and settings (schools, day care centres etc.) that are special to this setting and have been overlooked during the case study collection and review for the first WHO expert meeting in February 2008.

Health risks from exposure to dampness and mould in schools, offices and institutional buildings are assessed to be similar to risks from exposures in homes ([Mudarri D, Fisk WJ. 2007](#)). Home, school and day care centre are the most important indoor environments for school-aged children. However, in public institutions responsibilities for the building are often unclear and, additionally, are often shared among several partners. As a consequence, decision making and exchange of information is delayed.

A study in Sweden compared ordinary day-care centres (ODC) with “allergen avoidance day-care centres” (AADC), which are existing since 1979. The AADCs are financed within municipal budgets and exist in all areas of Sweden. On average, the AADCs were newer, numbers of children per section were lower and pets were very rare. There were fewer complaints about indoor odours in general, furnishing and fixtures were less common, pot plants were rare and the frequency of cleaning was higher. History of dampness and indoor mould was found less often in AADCs, a total of 25.3% of the AADCs and 39.1% of the ODCs had either past or present signs of building dampness or indoor mould growth. Dampness or mould previous to the last year more often occurred in ODCs (31.9%) than in AADCs (20.5%). Sections that had dampness during the last year or ever more often were located in older buildings.

A second predictor of dampness or mould was a flat roof, 31.6% of all day-care centres with dampness problems had a flat roof. Wet mopping, type of floor or external building material or presence/absence of basement were not related to dampness or mould problems ([Bröms et al. 2006](#)). [Lignell et al. \(2007\)](#) repaired a moisture-damaged school (index school) for all faults identified and compared it with a reference school (not damaged, hence not repaired) during five consecutive years.

In the two preceding years before the renovation, in the year of the renovation and in the 4th and 5th year after renovation the authors carried out sampling campaigns for airborne viable microbes, and symptoms of the pupils were assessed using questionnaires. All investigations were conducted during wintertime. In the 5th year a thorough cleaning in the index school was conducted. This was necessary to normalise microbial concentrations, only after this thorough cleaning the microbial profile approached that of the reference school. Additionally the authors found that the year-to-year variation in microbial concentrations partially exceeded the effect of renovation measures. Because of changing weather conditions, the use of a reference building was important. Other factors than renovation measures probably also seem to have an influence on pupils' symptoms.

[Meklin et al. \(2005\)](#) investigated the effects of remediation on symptom prevalence and microbial status in two moisture-damaged and two non-damaged schools. Remediation comprised of

- School A (completely repaired):
 - structures opened and renewed
 - renewing of land-drains / drain, heating and water pipes /all coating materials
 - installation of ventilation, alteration from natural ventilation to mechanical exhaust and air supply
 - thorough cleaning of the school

- School B (partially repaired):
 - drying of ground structures, renewing of floor and wall coatings of the main corridor in the ground floor
 - renewing of land-drains and external moisture barriers
 - maintenance of existing mechanical exhaust ventilation system, thorough cleaning of ventilation ducts
 - thorough cleaning of the school

Because of their extent, the repairs were conducted during the holidays in schools, when the buildings were unoccupied and lasted 2 to 3 years. In school A, elevated concentrations of indoor air fungi normalised and the prevalence of 10 of 12 symptoms assessed by questionnaire decreased significantly after full remediation. Partial repair of school B did not cause a change in microbial conditions, and only a slight improvement in symptom prevalence was observed. The authors state that both the improvement of ventilation and elimination of the emission sources may often be needed to solve indoor air problems. They also mention that monitoring of viable microbes in the air can be used to assess the microbial status of the indoor environment.

[Koivisto et al. \(2002\)](#) classified 41 school buildings into two categories depending on whether they had notable moisture damage observations (31 buildings) or not (10 buildings). The classification was used to evaluate the effects of different building characteristics such as age, predominant building materials and type of structural assemblies on the occurrence of moisture damage. Moisture damage characteristics were analysed to assess their distribution and inter relationships. Of all damaged sites 23% were located in classrooms, 20% in wet rooms, 12% in corridors and 6% in kitchens. Concerning structure type, 27% of floor structures, 19% of partition walls, 17% of external walls, 15% of upper floors and 8% of uppermost floors were damaged. Technical aging was the most common reason for damage (27%). Other reasons were related to moisture sources outside the buildings like surface or rising water (22%) or water leaks (13%) of the damage observations.

[Haverinen et al. \(1999\)](#) conducted structural, microbial and health effect studies of three different types of moisture damaged school buildings of a school centre. Their study group consisted of experts in civil engineering, indoor mycology and epidemiology and worked in close cooperation with the city administration.

They stated that types of moisture damages can be divided into 4 categories:

- Incorrect methods of construction, maintenance or repair
- Moisture penetrating from the ground
- High moisture load from ordinary use (e.g. kitchen)
- External factors like fire fighting or water leaks

The authors also pointed out that information about the facilities where the users had experienced problems, obtained from the questionnaire, might be helpful to identify problems in building construction. Communication with the occupants of the buildings, e.g. providing them with information about the study, the measurements and the results, helped to establish a constructive discussion. The authors point out the importance of public meetings to keep the atmosphere open. In case of public buildings, responsibility often is not clear and outside consultants may be necessary.

A possibility to reduce contamination in HVAC systems was investigated by [Menzies et al. \(2003\)](#). In office buildings, they conducted a double blind crossover study with 771 participants over 1 year. In the ventilation system of three office buildings with low pre-intervention microbial contamination in Montreal, Canada (with sealed windows, mechanical ventilation and air conditioning in which smoking was not allowed) ultraviolet germicidal lights (UVGI) were in-

stalled. The UV-irradiation was turned on for 4 weeks, followed by 12 weeks without irradiation, this regimen was repeated three times.

The above treatment led to a substantial reduction in microbial surface contamination (5 of 7 common fungal species disappeared) and a large decrease in work-related symptoms. Amongst fungi, UVGI eliminated almost entirely all surface bacteria.

[Bernstein et al. \(2005\)](#) conducted a pilot study to investigate the effect of dehumidification in conjunction with high efficiency particulate arrestance (HEPA) filtration on temperature, dew point and airborne mould spore counts in two day care centres. None of the two facilities had indoor mould problems. The day care centres were within a 2-mile radius. Day care centre A was located in a two years old building with eight rooms, day care centre B was 15 years old with six rooms. In half of the rooms, a dehumidification unit equipped with a HEPA filter was installed (intervention). Indoor room dew point was measured continuously, temperature every two hours throughout the study. Fungal air sampling was conducted every three months during a period of one year. Compared with baseline, the average dew point was lower in rooms after the intervention after adjustment for temperature. Baseline and follow-up mean fungal spore counts were lower in intervention rooms, but the change from baseline to end of follow-up differed between rooms with and without intervention in the two facilities. The effect of intervention was statistically significant for facility A, but not for facility B. The authors conclude, that according to the results of the study, dehumidification is effective in reducing indoor dew point and relative humidity, respectively. This effect was (1) independent of temperature, which is remarkable considering the amount of daily activity in day care centres that can result in fluctuations of relative humidity and (2) occurred in spite of inter-room air circulation, which could have lessened the outcome of dehumidification in the intervention rooms.

[Huttunen et al. \(2008\)](#) followed the success of repairs in two different buildings by analysing the microbial flora and immunotoxicological activity of filter samples indoors and outdoors both before and after remediation. Location 1 is a complex of educational buildings with a wooden structure built in the 1940s. Measurements were conducted in two of the buildings, in one building severe mould problems occurred, and the other (the reference building) had been renovated earlier and currently no problems with mould or moisture were known. Location 2 is a 15-year old concrete-framed building. Problems with mould and moisture were due to roof leakage and capillary suction. A similar building in the neighbouring town having no visible signs of moisture problems was selected as a reference building. In location 1, the remediation resulted in only slight differences in the concentration of fungi, whereas the immunotoxicological activity of the particles collected from the damaged building decreased. In the Location 2, the remediation resulted in a decrease in the concentration of fungi, whereas no effect on the immunotoxicological responses was detected. Immunotoxicological responses to the indoor air samples from building 2 were almost identical to those caused by the samples from outdoor air. The authors hypothesize that the effects of remediation on the indoor air quality may not necessarily be readily measurable with microbial or toxicological parameters, which might be associated with the different spectrum of harmful agents in different mould and moisture-damaged buildings. They conclude that “every location with an indoor air problem has its own set of exposure agents; thus it may be misleading to try to fit the same aetiology when, in fact, the origin of the health problems is different. Multifactorial approaches and diverse analyses of both indoor and outdoor air are necessary to reveal the underlying situation behind the indoor air problem. Thus, there is not yet a single analysis that would describe all possible harmful agents in mould and moisture-damaged buildings.”